In the Claims

1. (Currently amended) A method for characterizing a contaminant in a fluid flow system, comprising the steps of:

(a) injecting a conservative gaseous tracer and an interactive gaseous tracer into the flow system at a first location, wherein the flow system is not completely filled with liquid;

(b) advecting the tracers along the flow system;

(c) extracting the tracers at a second location in the flow system;

(d) measuring the concentration of the extracted tracers over a period of time; and

(e) characterizing the contaminant from the concentrations of the tracers.

2. (Original) The method of claim 1 where the concentration is measured as a function of time.

3. (Original) The method of claim 1 wherein the characterizing includes detecting the presence of a specific contaminant of interest in the fluid flow system.

4. (Original) The method of claim 1 wherein the characterizing includes locating a specific contaminant of interest in the fluid flow system.

5. (Original) The method of claim 1 wherein the characterizing includes quantifying the amount of a specific contaminant in the flow system.

6. (Original) The method of claim 1 wherein the tracers are advected by a fluid that does not

interact with the tracers or the contaminant.

7. (Original) The method of claim 1 wherein the interactive tracer is a partitioning tracer.

8. (Original) The method of claim 1 wherein the interactive tracer is a reactive tracer.

9. (Original) The method of claim 1 wherein a plurality of interactive tracers are injected.

10. (Currently amended) A method for detecting the presence of a contaminant in a fluid flow system, comprising the steps of:

(a) injecting a conservative gaseous tracer and an interactive gaseous tracer into the flow system at a first location, wherein the flow system is not completely filled with liquid;

(b) advecting the tracers along the flow system with a fluid that does not interact with the tracers;

(c) extracting the tracers at a second location in the flow system;

(d) measuring the concentration of the extracted tracers over a period of time; and

(e) detecting the presence of the contaminant from a comparison of the measured concentrations.

11. (Original) The method of claim 10 where said concentration is measured as a function of time.

12. (Original) The method of claim 10 wherein the interactive tracer is a partitioning tracer.

13. (Original) The method of claim 10 wherein the interactive tracer is a reactive tracer.

14. (Original) The method of claim 10 wherein a plurality of interactive tracers are injected into the fluid flow system.

15. (Original) A method for determining the location of a contaminant in a fluid flow system, comprising the steps of:

(a) injecting a conservative tracer and a partitioning tracer into the flow system at a first location;

(b) advecting the tracers along the flow system at a first velocity to create an advection flow field;

(c) extracting the tracers at a second location in the flow system;

(d) introducing a perturbation to the advection flow field at a perturbation time by changing and then re-establishing the advection flow at a second velocity, which may be different than the first velocity, creating a unique change in the concentration of the partition tracer;

(e) extracting the partitioning tracer as a function of time relative to the perturbation time;

(f) measuring the concentration of the partitioning tracer as a function of the time; and

(g) determining the location of contamination from the time of arrival of the partitioning tracer relative to the perturbation time and the advection flow velocity.

16. (Original) A method for determining the quantity of a contaminant in a fluid flow system, comprising the steps of claim 1, wherein the quantity of extracted tracer is related to the quantity of contaminant.

17. (Original) An apparatus for characterizing a contaminant in a fluid flow system, comprising:

(a) a tracer injection system for injecting known amounts of conservative and interactive tracers into the flow system;

(b) ~~an~~ a gaseous advection driving system for moving the tracers along the flow system at a known flow rate;

(c) a tracer extraction system for removing the tracers from the fluid flow system;

(d) a measurement system for determining the concentration of the tracers extracted from the fluid flow system; and

(e) a processor for analyzing the concentration measurements.

18. (Original) The apparatus of claim 17, wherein the injection system includes a container with a valve holding tracers at pressure, whereby the tracers can be injected into the flow system by depressurizing the container by opening the valve on the container.

19. (Original) The apparatus of claim 17, wherein the driving system includes a compressed gas cylinder.

20. (Original) The apparatus of claim 17, wherein the measurement system includes a gas chromatograph.

21. (New) The method of claim 1 wherein the method of characterizing can be used to characterize said contaminant at more than one location when the tracer concentrations from each location are distinguishable.

22. (New) The method of claim 1 wherein the method of characterizing can be used to characterize more than one contaminant in a fluid flow system by using one or more tracers that interact with each contaminant.

23. (New) The method of claim 1 wherein the method of characterizing can be used to characterize a plurality of contaminants at a plurality of locations.

24. (New) The method of claim 2 wherein said characterizing involves a comparison of the characteristic features of the measured concentrations of the conservative and interactive tracers.

25. (New) The method of claim 24 wherein said characteristic features are comprised of the magnitude of the tracer concentrations in certain regions of the concentration curves such as the peak, the leading edge, or the trailing edge of the curves.

26. (New) The method of claim 24 where said comparison is accomplished using said tracer concentration curves that represent only a fraction of the total concentration curve that would have been measured if the collection time were extended.

27. (New) The method of claim 10 wherein the method of detecting can be used to detect said contaminant at more than one location when the tracer concentrations from each location are distinguishable.

28. (New) The method of claim 10 wherein the method of detecting can be used to detect more than one contaminant in a fluid flow system by using one or more tracers that interact with each contaminant.

29. (New) The method of claim 10 wherein the method of detecting can be used to detect a

plurality of contaminants at a plurality of locations.

30. (New) The method of claim 11 wherein said detecting is determined from a comparison of the characteristic features of the measured concentrations of the conservative and interactive tracers.

31. (New) The method of claim 30 wherein said characteristic features are comprised of the magnitude of the tracer concentrations in certain regions of the concentration curves such as the peak, the leading edge, or the trailing edge of the curves.

32. (New) The method of claim 30 where said comparison is accomplished using said tracer concentration curves that represent only a fraction of the total concentration curve that would have been measured if the collection time were extended.

33. (New) The method of claim 15 wherein the injecting and the advecting in steps (a) and (b) of claim 15 are done to inundate the entire fluid flow system with the tracers.

34. (New) The method of claim 15 wherein a plurality of partitioning tracers are used.

35. (New) The method of claim 15 wherein the presence of the partitioning tracer after the perturbation needed for location of the contaminant is also used to detect the presence of the contaminant.

36. (New) The method of claim 15 wherein the time of arrival is determined from the leading edge of the tracer concentration curve.

37. (New) The method of claim 15 wherein said second flow velocity is determined from the mean time of arrival of the tracer at said second flow rate.

38. (New) The method of claim 15 wherein the location of the contamination is further comprised of the steps of (a) extracting the partitioning tracer at said second location at said first flow rate and measuring the concentration of the partitioning tracer over a period of time and (b) determining the location of the contaminant from (1) the times of arrival of the partitioning tracer relative to the start time of the second advection flow after the perturbation and to the start time of the first advection flow and (2) the flow rates of the second advection flow and the flow rate of the first advection flow.

39. (New) The method of claim 15 wherein the method of location can be used to locate said contaminant at more than one location when the tracer concentrations from each location are distinguishable.

40. (New) The method of claim 15 wherein the method of location can be used to locate more than one contaminant in a fluid flow system by using one or more tracers that interact with each contaminant.

41. (New) The method of claim 15 wherein the method of location can be used to locate a plurality of contaminants at a plurality of locations.

42. (New) The method of claim 16 wherein the quantity of a contaminant in a fluid flow system is determined from the time of arrival of the conservative and the interactive tracer.

43. (New) The method of claim 16 wherein the interactive tracer is a partitioning tracer.

44. (New) The method of claim 16 wherein the interactive tracer is a reactive tracer.

45. (New) The method of claim 16 wherein a plurality of interactive tracers are injected.

46. (New) The method of claim 16 in which the partitioning tracers have sufficient time to fully dissolve and interact with the contaminants in the fluid flow system.

47. (New) The method of claim 16 wherein said quantification is determined from a comparison of the characteristic features of the measured concentrations of the conservative and interactive tracers.

48. (New) The method of claim 33 wherein the partitioning tracer that is injected into the fluid flow system is allowed sufficient time for the tracer to interact with the contaminant before the tracer is advected.

49. The method of claim 33, wherein only the section of the fluid flow system that is contaminated need be inundated with tracer.

50. (New) The method of claim 33 wherein the presence of the partitioning tracer after the perturbation needed for location of the contaminant is also used to detect the presence of the contaminant.

51. (New) The method of claim 33 wherein the time of arrival is determined from the leading edge of the tracer concentration curve.

52. (New) The method of claim 33 wherein said second flow velocity is determined from the mean time of arrival of the tracer at said second flow rate.

53. (New) The method of claim 33 wherein the method of location can be used to locate said contaminant at more than one location when the tracer concentrations from each location are distinguishable.

54. (New) The method of claim 33 wherein the method of location can be used to locate more than one contaminant in a fluid flow system by using one or more tracers that interact with each contaminant.

55. (New) The method of claim 33 wherein the method of location can be used to locate a plurality of contaminants at a plurality of locations.

56. (New) The method of claim 35 wherein the method of detection can be used to detect said contaminant at more than one location when the tracer concentrations from each location are distinguishable.

57. (New) The method of claim 35 wherein the method of detection can be used to detect more than one contaminant in a fluid flow system by using one or more tracers that interact with each contaminant.

58. (New) The method of claim 35 wherein the method of detection can be used to detect a plurality of contaminants at a plurality of locations.

59. (New) The method of claim 35 wherein said detecting is determined from a comparison of the characteristic features of the measured concentrations of the conservative and interactive tracers.

60. (New) The method of claim 50 wherein the method of detection can be used to detect said contaminant at more than one location when the tracer concentrations from each location are distinguishable.

61. (New) The method of claim 50 wherein the method of detection can be used to detect more than one contaminant in a fluid flow system by using one or more tracers that interact with each contaminant.

62. (New) The method of claim 50 wherein the method of detection can be used to detect a plurality of contaminants at a plurality of locations.

63. (New) The method of claim 50 wherein said detecting is determined from a comparison of

the characteristic features of the measured concentrations of the conservative and interactive tracers.

64. (New) The method of claim 37 wherein said mean time of arrival is determined from the centroid of the tracer concentration curve.

65. (New) The method of claim 38 wherein the location is determined from the product of the ratio of the time of arrival of the partitioning tracer at the second flow rate relative to the first flow rate, the ratio of the flow rate of the partitioning tracer at the second flow rate relative to the first flow rate, and the length of the fluid flow system between the injection and extraction points.

66. (New) The method of claim 52 wherein said mean time of arrival is determined from the centroid of the tracer concentration curve.

67. (New) The method of claim 50 wherein said characteristic features are comprised of the magnitude of the tracer concentrations in certain regions of the concentration curves such as the peak, the leading edge, or the trailing edge of the curves.

68. (New) The method of claim 50 where said comparison is accomplished using said tracer concentration curves that represent only a fraction of the total concentration curve that would have been measured if the collection time were extended.

69. (New) The method of claim 63 wherein said characteristic features are comprised of the magnitude of the tracer concentrations in certain regions of the concentration curves such as the

peak, the leading edge, or the trailing edge of the curves.

70. (New) The method of claim 63 where said comparison is accomplished using said tracer concentration curves that represent only a fraction of the total concentration curve that would have been measured if the collection time were extended.

71. (New) The method of claim 43 for determining the quantity of a contaminant in a fluid flow system wherein the partitioning coefficient of the partitioning tracer is known.

72. (New) The method of claim 71 in which the quantity of the contaminant is determined from the ratio of the mean time of arrival of the partitioning and conservative tracers.

73. (New) The method of claim 71 in which said mean arrival times of the partitioning and the conservative tracers are be determined from the centroid of said tracer concentration curves.

74. (New) The method of claim 72 where said comparison is accomplished using said tracer concentration curves that represent only a fraction of the total concentration curve that would have been measured if the collection time were extended.

75. (New) The method of claim 74 where said comparison is accomplished with said fractional concentration curve by mathematically extrapolating the curve.

76. (New) The method of claim 74 further comprising the step of applying a factor accounting for the geometry of the fluid flow system.

77. (New) The method of claim 47 wherein said characteristic features are comprised of the magnitude of the tracer concentrations in certain regions of the concentration curves such as the peak, the leading edge, or the trailing edge of the curves.